Software Maintenance Efficiency for Naval Aviation Systems: a Pragmatic Program Related Engineering (PRE) Strategy

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NAVAL AIR SYSTEMS COMMAND (NAVAIR) SOFTWARE SUPPORT ACTIVITIES (SSAs)

Integrated Government and Industry Teams Apply System & Software Engineering Knowledge and Skills to

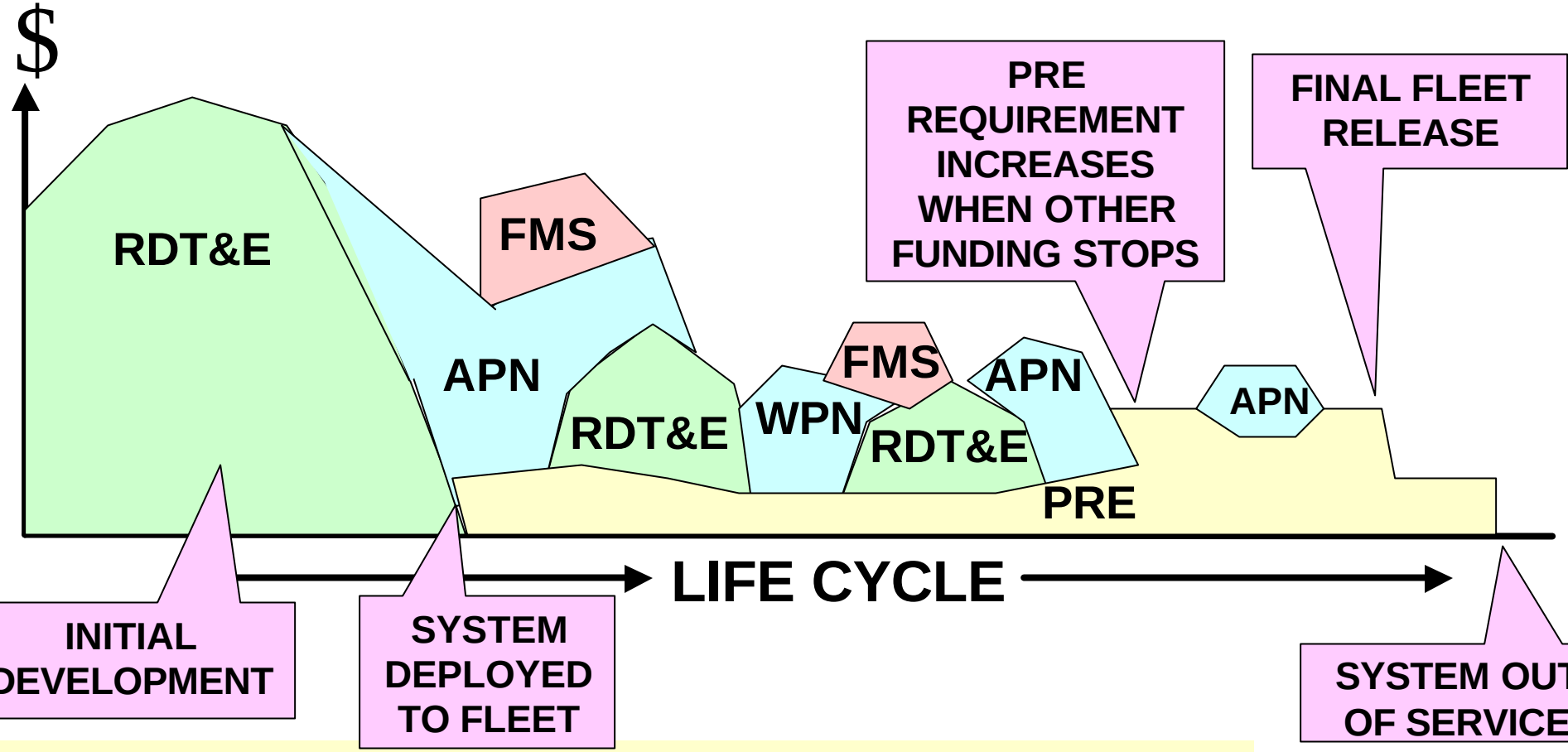
Transform Fleet Operational Needs into Fleet Operational Capability Over the System Life-cycle

FLEET DEPLOYED SOFTWARE IS NEVER 'OUT OF PRODUCTION'

- **Why?**
  - **Provides a Means for Our Fleet to Rapidly Adapt to the Changing Environment**
  - **New/Updated Sensors, Weapons, ETC.**
  - **Defect Correction**
  - **SW can Resolve Obsolescence Issues**
  - **Evolving Threats, Missions, Interoperablility**
- **Implication:**

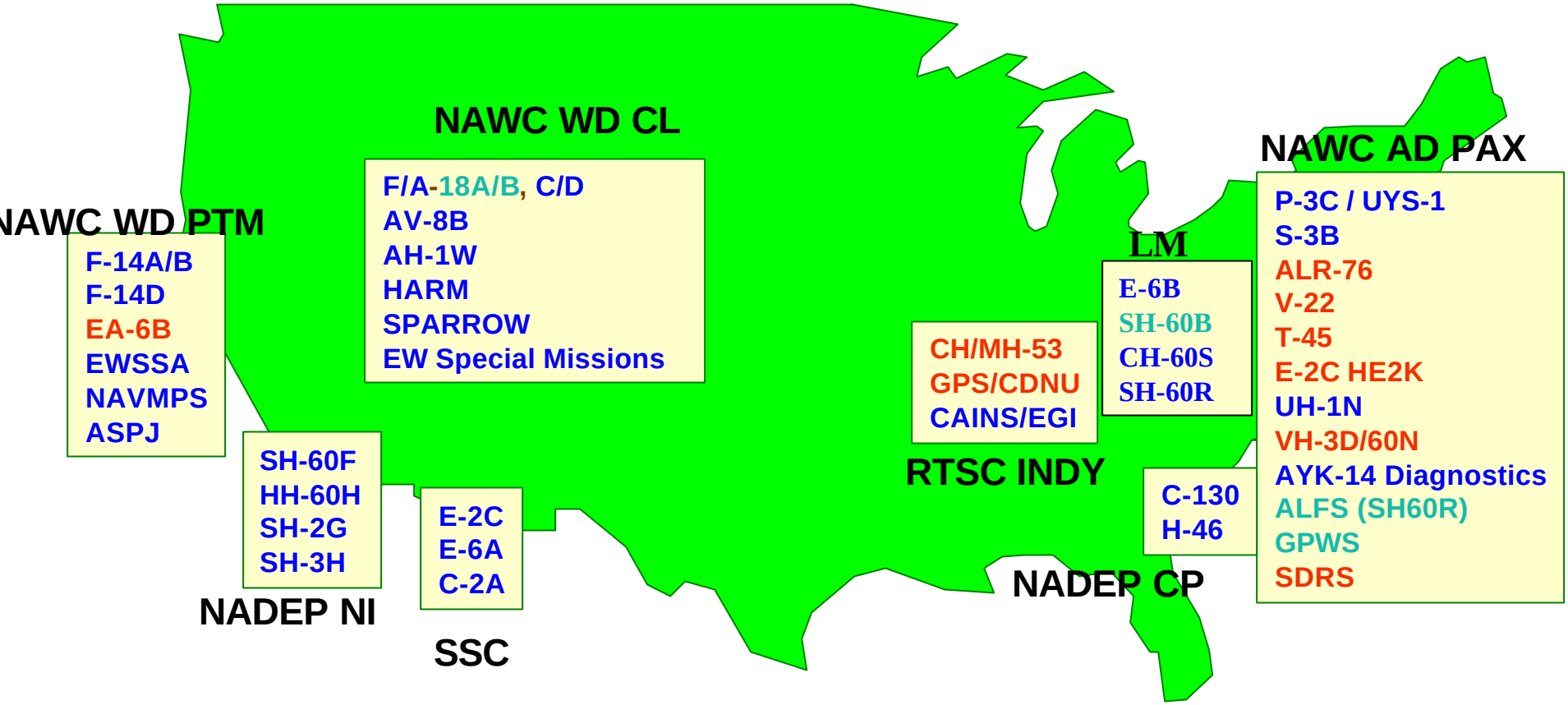
  Software 'Production line' Stays Open Throughout the Product Life-cycle
  - **Generation, Integration, and Test Facilities**
  - **Engineering Resources**

IDEALIZED SOFTWARE FUNDING REQUIREMENT PROFILE OVER A SYSTEM'S LIFE CYCLE



RDT&E-development funds
APN & WPN- production funds
FMS- Foreign Military Sales
PRE-PROGRAM RELATED ENGINEERING- O&M,N-SW maintenance funds

PRE FUNDED SSAs



NAWC-Naval Air Warfare Center
NADEP- Navy Depot
SSC- SPAWAR Software Center
LM- Lockheed/Martin
RTSC- Raytheon Technical Services Center

% Program Funds to Contractor

- < 40%
- 40% < and > 75%
- > 75%

NAVAIR PRE SOFTWARE INVENTORY GROWTH

FY03 Software Inventory*

65,760,986 SLOC - Fleet Operational Software
31,502,256 SLOC - Related Support Software
97,263,242 total SLOC

110% Increase From FY01

*Non-Comment, Non-Blank, Logical Source Lines Of Code (SLOC)
Source: Annual PRE Requirements Review

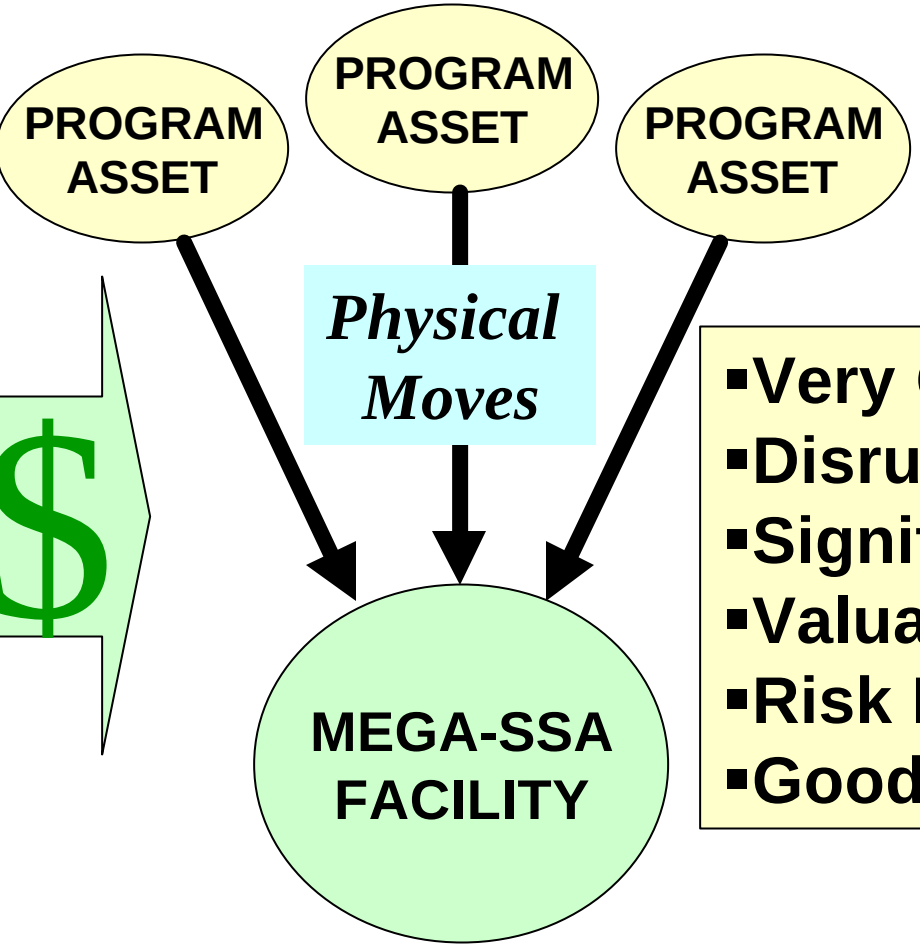
IMPLICATION OF GROWING SW INVENTORY

- Additional Fleet Release Products/Versions
- Additional Supporting Data, Documentation
- Additional Software Trouble Reports, Obsolescence, ETC
- Increased Resources Needed for Post
- Deployment Support by SSAs
  - ? Additional SW Generation Capability
  - ? Additional Integration and Test facilities
  - ? Additional Engineering Staff
  - ? Additional Funds Required!

HOW CAN SOFTWARE SUPPORT RESOURCE REQUIREMENTS BE MODERATED?

ROM OF SW INVESTMENTS:	POTENTIAL APPROACH Given limited time and funding
Software Products: 65M SLOC Code ~ $10,000,000,000+	**RE-DO SW To Improve Technology & Lower Maintenance Cost?** *Too Costly & Needs Other $*
Facilities: ~$1,000,000,000+ To Replace ~$100,000,000+ To Move	**Re-do or move facilities?** *Too Costly & Needs Other $*
Personnel: ~$100,000,000+	A. Replace Personnel? *No, Avoid - Too Costly* B. Make Personnel More Effective Via Process Initiatives? *YES Cost: ~ Several $Ms/yr (PRE Plus Other PDSS Funding) Return: ~ $10Ms/yr*

TRADITIONAL CONSOLIDATION



- Very Costly
- Disruptive to Fleet Support
- Significant Organization Disruption
- Valuable Personnel Lost
- Risk Damage to Valuable Equipment
- Good ROI Highly Doubtful

What is a <u>Good</u> Answer for SSAs???

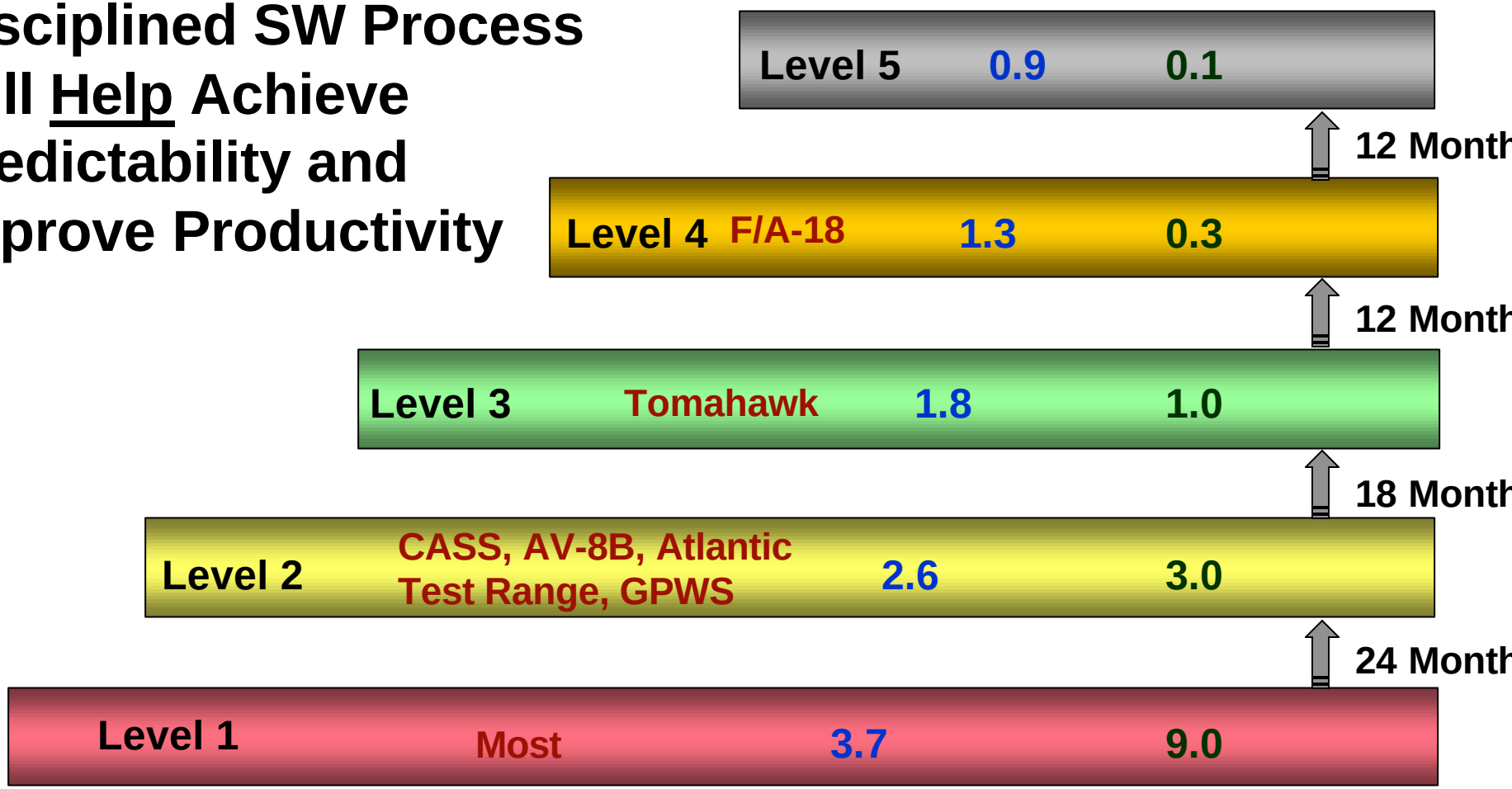
NAVAIR PROCESS IMPROVEMENT INITIATIVES

- **System/Software Process Improvement (SPI) Via SEI* Software Capability Maturity Model (CMM) and Related Models Which Provide Guidance to Organizations on How to Gain Control of Their Processes for Developing and Maintaining Software**
  - **Five Levels of Maturity. Save 10% to 30% Per Level (5 levels) of Process Improvement Achieved**
  - **1 to 2 years Required to Achieve Each Level**
- **SSA Restructure Plan**
  - **Objectives:**
    - **Effectively Share People Resources Between Projects/Across Sites**
    - **Share/Consolidate Lab Resources Between Projects/Across Sites**

*SEI: Software Engineering Institute

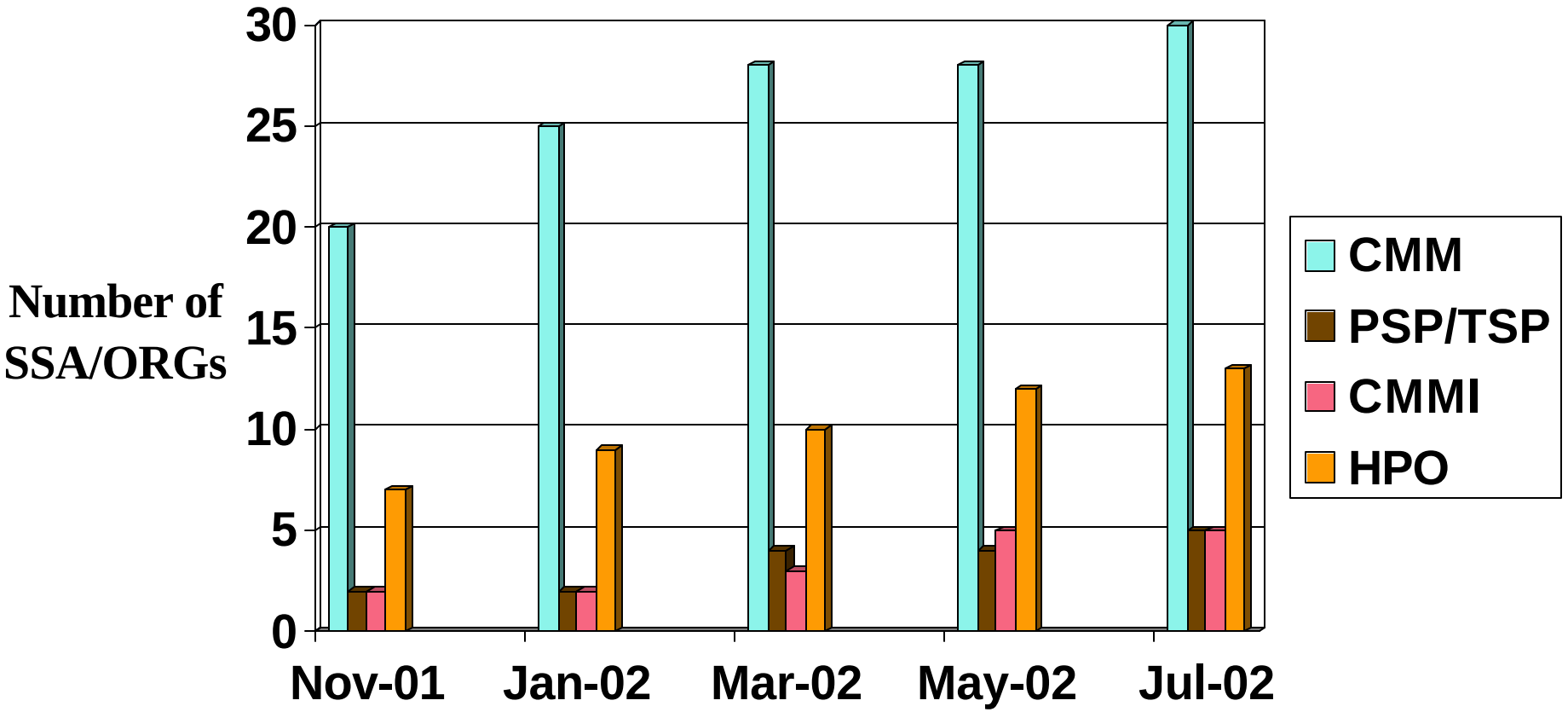
NAVAIR SW-CMM JOURNEY

Disciplined SW Process Will Help Achieve Predictability and Improve Productivity



etric Sources:
1994 Citibank Analysis
Applied Software Measurement, Capers Jones
Benchmarking F/A-18 Mission Computer Inspection 1998

NUMBER OF SSAs WITH SPI UNDERWAY IS INCREASING



Increased Funding is Needed to Accelerate Progress

SSA RESTRUCTURE APPROACH . . .

- Three Phased Evolutionary Approach (3 phases, 6 years)
- Joint Program Office/Competency Effort
- Take Advantage of SPI Initiatives Underway and Common Processes Which Facilitate Potential Sharing of Personnel Across Programs
- Facilitate Sharing and Consolidation of Facility Resources
- Facilitate the Restructure of NAVAIR Software Support Groups Around Domain / Product Areas Vs Individual Projects/Products
- Assist Programs vs Disrupt Fleet Support
- Help Programs Solve the Problem of Lost and Fluctuating Funding

TRADITIONAL
Vs
RESTRUCTURE PARADIGM

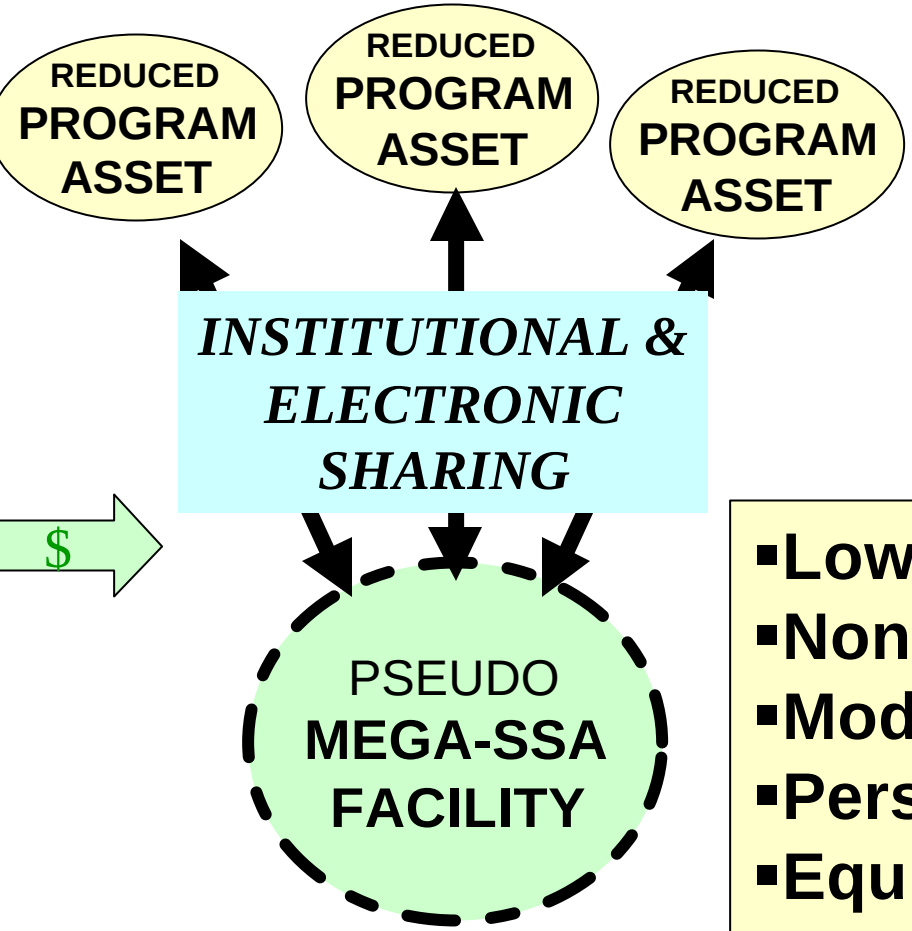
TRADITIONAL

- Individual SSA for Each Project/System
  - Unique Processes, Some Poorly Defined
  - Unique Procedures, Labs, Mission Areas
  - Individual Fixed Job Assignments
  - Full SSA/Funding Needed for Efficient Operation

RESTRUCTURE VISION

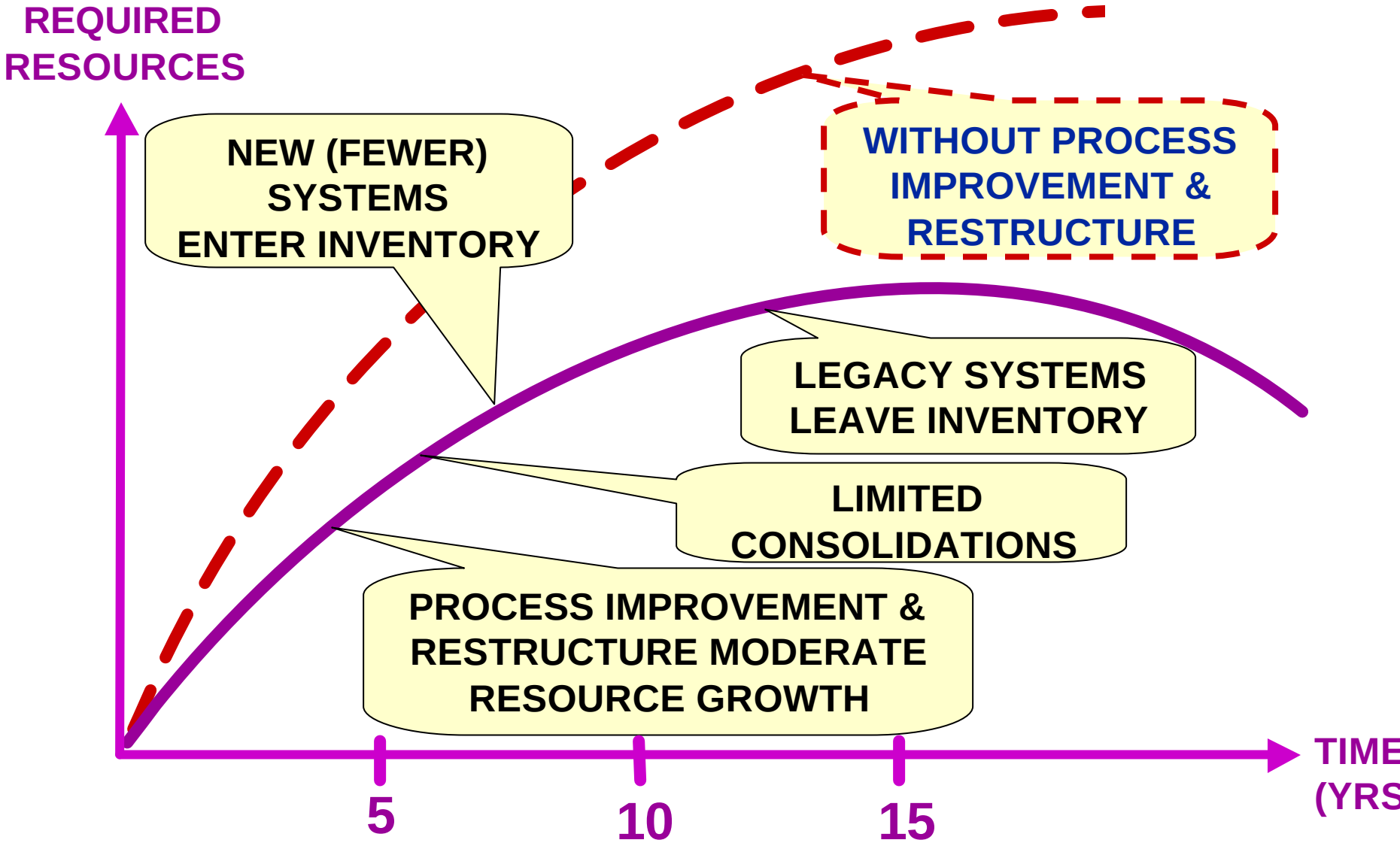
- NAVAIR Assets Support Multiple Projects
  - Processes Well Defined, Many Common
  - Both Unique & Common Procedures, Labs, Mission Capability Areas (Process, Labs Shared)
  - Many 'Rotational' Job Assignments (Personnel Shared)
  - Efficient at Less Than 'Full Funding'

RESTRUCTURE



- **Low Cost**
- **Non-Disruptive to Fleet Support**
- **Modest Organizational Change**
- **Personnel Enabled/Optimized**
- **Equipment & Staff Asset Requirements Moderated**
- **Good ROI Likely**
- **SPI is a Co-Requisite**

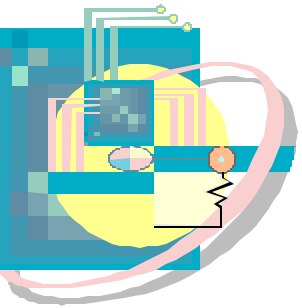
LONG TERM NAVAIR SOFTWARE SUPPORT COSTS



SUMMARY

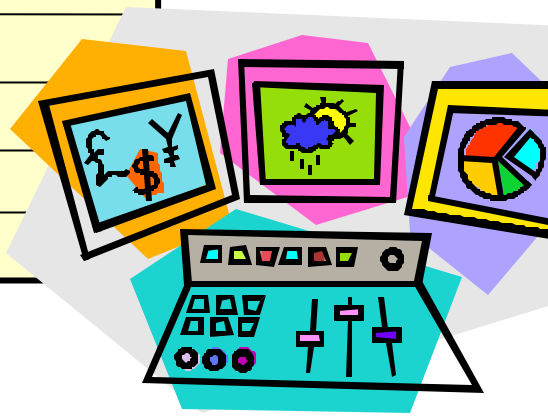
- **Cornerstone of Cost-effective Software Support: SEI Based Process Improvement**
- **Increasing NAVAIR Software to Support with Limited Resources**
- **Need to Support 'Legacy Systems' Next 10+ Years Without Benefit of Common Systems, Open Architectures, OOD, Etc.**
- **Also: Restructure of Traditional Project Organization to Effectively Share (Institutionally & Electronically) Personnel and Laboratory Resources Across the Entire NAVAIR Corporation**

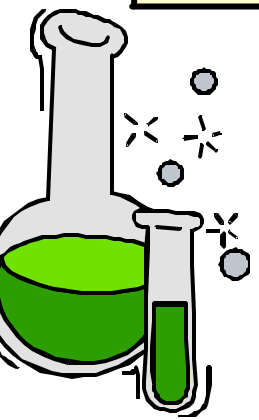
BACKUP SLIDES



AIR WEAPONS SYSTEMS ARE INCREASINGLY SW INTENSIVE

Weapons	Year	% of Function Performed in SW
F-4	1960	8
A-7	1964	10
F-111	1970	20
F-15	1975	35
F-16	1982	45
B-2	1990	65
F-22	2000	80



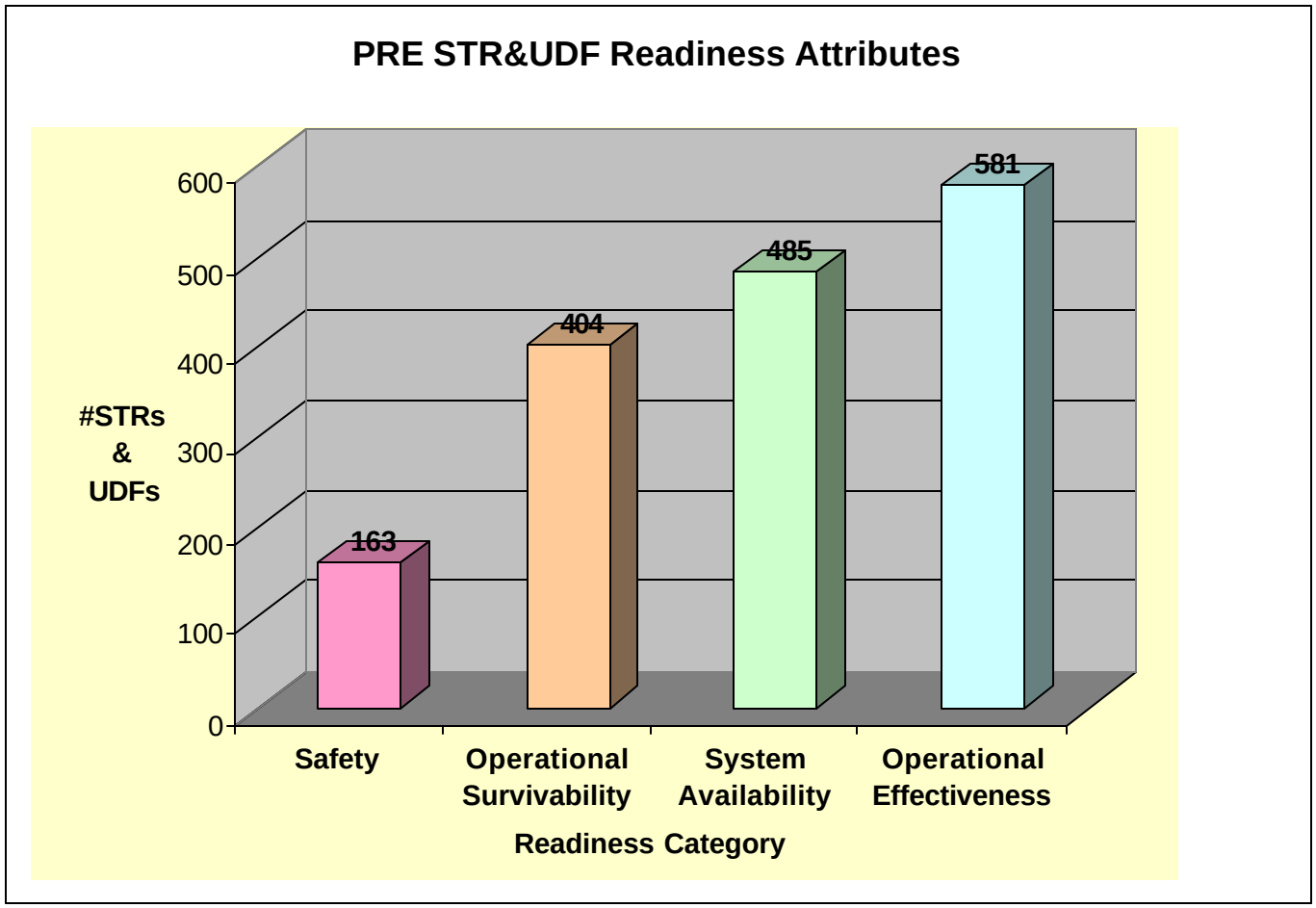


- **More functions are performed by SW**
- **SW is the most current technological advancement**
- **Because of SW's "newness" it is a terribly miss understood "art"**

PROGRAM RELATED ENGINEERING (PRE) BUDGET

- Operations And Maintenance, Navy (O&M,N) Budget for NAVAL Aviation Software Maintenance
- Provides Foundation for Post Deployment Software Support of NAVAL Air Systems
- Approx 50 Software Support Activities (SSAs)
  - Air Platforms (29)
  - Common Avionics Subsystems SSAs (17)
  - Mission Planning SSAs (2)
  - Avionics Diagnostic Software SSAs (2)
- Funds:
  - Sustainment of Requisite Engineering Support & Generation and Integration Test Facilities
  - Correction of Fleet Software Trouble Reports (STRs) and update of User Data Files (UDFs) /Threat Libraries

PRE REQUIREMENT CHARACTERIZATION BY STR AND UDF READINESS CATEGORY



(Includes Only STRs & UDFs Highest Ranked by the Fleet)

STR PRIORITIES

1 Prevent the Accomplishment of an *Operational or Mission* Essential Capability; and/or Jeopardize Safety, Security, or Other Requirement Designated "Critical"

2 Adversely Affect the Accomplishment of an *Operational or Mission* Essential Capability and No Work-Around Solution is Known.; and/or Adversely Affect Technical, Cost or Schedule Risks to the Project or to Life Cycle Support of the System and No Work-Around Solution is Known.

3 Same as Priority 2 but a Work-Around Solution is Known.

PRE Guidebook per IEEE/EIA 12207.2 & MIL-STD-498

READINESS ATTRIBUTE CATEGORIES FOR STRS AND UDFs

SAFETY- Problem With Level I or II Safety Critical System Software

OWN SURVIVABILITY-Substantially Endanger Own Unit/platform During Mission Operations

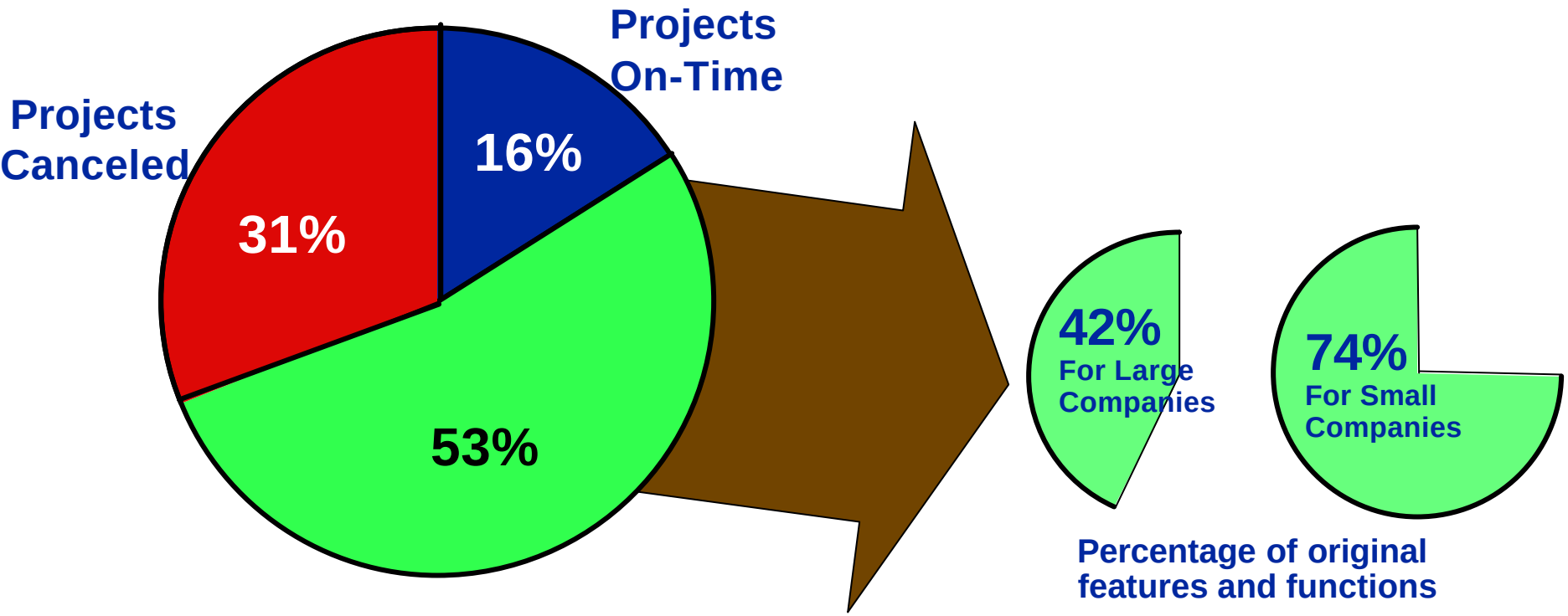
OTHER SURVIVABILITY-Substantially Endanger Others During Mission Operations (Battle Group, Friendly Forces/civilians Etc.)

OPERATIONAL AVAILABILITY- Degrades Critical System Availability, Response Time, Cost Effectiveness

OPERATIONAL EFFECTIVENESS- Degrades Mission Effectiveness

SOFTWARE INDUSTRY

Because software production is such a new industry there are risks.
Software production has not yet matured to the point of hardware production.



Projects With Schedule Overrun (typically by 189%)

- **Percentages for $500k to $2.3M projects**
  Cost/schedules worse on large projects
- **$81B in Government projects canceled in 1995**

Sources: Standish Group International, Inc.

Brown, Norm; Industrial Strength S/W Management; IEEE

PROCESS INITIATIVES

- **Initiatives approved by and under oversight by the NAVAIR System Leadership Council (SLC)**
  - **– Software Resource Center (SRC)- NAVAIR Team providing help in process improvement planning, use of software policies & guidelines; advice and referral; and repository of software processes, policies, lessons learned, etc.**
  - **– Software Leadership Team (SLT)- Working Groups that help establish common NAVAIR software processes, policy, guidance**
  - **– Project Process Improvement – funding and assistance to projects to carry out SEI CMM* Based Software Process Improvement (SPI) Initiatives resulting in lower cost, lower risk, shorter schedule, higher quality software products for the Fleet**
  - **– SSA Restructure- promote resource sharing and consolidation among SSAs**

SOFTWARE PROCESS IMPROVEMENT (SP

- The Software Engineering Institute (SEI) Developed the Capability Maturity Model (CMM) for Software
- The CMM Provides Software Organizations with Guidance on
  - How to Gain Control of Their Processes for Developing and Maintaining Software
  - How to Evolve Toward a Culture of Software Engineering and Management Excellence
  - CMM Levels Range From 1 to 5, 5 Being The 'Best', Cost Savings Over 10% Per Level Have Been Experienced Over the Last Decade by Many Organizations
- Personal Software Process (PSP) and Team Software Process (TSP) and the Integrated CMM (CMMI) Models Also Being Applied
- High Performance Organization (HPO) Training Also Encouraged

NAVAIR PROGRAMS AT SW-CMM LEVEL 2 OR ABOVE